Generation and Characterization of Ultrashort Electron Pulses

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Femtosecond Electron Diffraction (FED) has been developed to directly observe structural transitions on the atomic scale in real time. The duration of the electron pulse dominates the time resolution of any current FED setup. Velocity mismatch between the electron probe and the laser pump pulse requires the use of transmission mode electron diffraction to achieve femtosecond temporal resolution. Hence, thin film samples with a thickness on the order of tens of nanometers have to be used. Intense heating of the sample due to the pump laser combined with the extreme surface-to-volume ratio makes most transitions non-reversible. A high number of electrons per pulse is thus required to achieve high signal-to-noise in one or few shots.

We have developed an electron gun that provides high flux electron pulses at pulse durations down to 250 fs. This has been achieved by minimizing the space-charge induced broadening of the electron pulses. Traditional methods for characterization of high flux electron pulses like streak cameras fail below the picosecond range. We have proposed the use of the ponderomotive potential [1] of an intense laser field to sample the temporal profile of the electron pulse by selectively scattering parts of the electron beam. This method and other approaches providing a direct cross-correlation between light and electron pulses hold promise of measuring pulses as short as 100 fs.

[1] Siwick B.J., Green A.A., Hebeisen C.T., Miller R.J.D., *Characterization of Ultrashort Electron Pulses by Electron-Laser Pulse Cross-Correlation*, *in press*.

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